Scenarios

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IN THIS CHAPTER YOU WILL LEARN ABOUT:

- The utilization of scenarios in the design of national forest strategies and policies in different regions
- New concepts such as supply-driven and demand-driven scenario types as well as research-initiated and policy-targeted scenario modeling types
- Typical scenario modeling process with linkages to NFA and NFP (national forest programs)
- Linkages to different scenario tools and case studies

Abstract

Forests are expected to provide multiple products and services for current and future generations. National Forest Monitoring and Assessment produces information on current forest resources and their changes. The future forest resources and their use potentials are more difficult to estimate because they depend on both current forest resources and their management. Correspondingly, the decisions concerning forest management strategies affect the future forest resources, products and services. Scenarios are useful tools to make the strategy options and their consequences more transparent for participatory and collaborative decision and policy making processes such as National Forest Programmes (NFPs). There are different approaches and tools used for scenario modeling at national, sub-national and local level such as trend extrapolation, matrix models and stand-level or regional level forest dynamics models, often used together with forest sector models. In the future, the compatibility of NFPs and their reference scenarios with sustainable development, international agreements and global markets becomes increasingly important. Therefore FAO supports the harmonization through, for example, Global Forest Reseource Assessment, National Forest Monitoring and Assessment projects, National Forest Programme Facility and UN-REDD Programme.

Introduction

Both developed and developing countries have been challenged by sustainable forest management (SFM). Firstly, SFM covers a wide variety of economic, ecological, social and cultural factors. In addition to industrial round wood and fuel wood, non-timber forest products and the role of forests in protecting biodiversity and water resources or providing facilities for recreation and carbon dioxide storage should be taken into account. To compensate the protective measures payments for ecosystem services (PES) have been introduced. Consequently, there may exist several alternative combinations of forest products and services and corresponding management strategies for a given country. Large-scale industrial plantations, small-scale community forest plantations, agroforestry, strict forest protection, forest rehabilitation and ecosystem approach for multiple-use forest management, or any combination of them, may be optional management strategies for many developing countries. At the same time developed countries may consider different national strategies to utilize the potential of forests in climate change mitigation, for example how much carbon should be stored in harvested wood products and how much in growing stock. Secondly, the objectives in terms of different forest products and services together with the corresponding forest management strategies and policy measures should be defined collaboratively with the stakeholders and decision makers that are later to be involved in the implementation. The framework for this kind of participatory process aiming at sustainable and multi-purpose forest management through collaboration is referred to as *National Forest Programme (NFP)*.

The role of NFP in a given country is to formulate activities and policy programmes towards the desired future in terms of sustainable use, conservation and development of forests. Because the future forest resources and their use potentials depend on adopted forest management strategies, the evaluation of alternative strategies and their consequences in terms of future forest products and services is an important part of participatory and collaborative decision and policy making processes. Scenarios are useful tools to make the strategy options and their consequences more transparent. Scenarios can be used, for example, to determine the impacts of different management strategies such as shifts in land-use, establishment of plantations, investments on fertilization programs, or to analyze impacts of different utilization rates on future wood resources.

Intergovernmental dialogue has recognized the essential role of NFPs in addressing forest sector issues. Therefore FAO established in 2002 an NFP facility to assist countries in developing and implementing NFPs that effectively address local needs and national priorities and reflect internationally agreed principles (country leadership, participation and integration of cross sectoral issues). An ideal NFP is a cyclical process split into four phases: analysis, policy formulation and strategic planning, implementation and monitoring and evaluation. It is obvious that *National Forest Monitoring and Assessment (NFMA)*, also supported by FAO, plays an important role in the analysis and monitoring stages. In the policy formulation and strategic planning stage, additional future-oriented tools such as scenarios are needed.

The objective of this article is to introduce different scenario modeling approaches, to outline a typical scenario modeling process with linkages to NFMA and NFP and, finally, to discuss some future challenges of scenario modeling. The article focuses on the potential of scenarios in the design of national forest strategies and policies. For more information on spatially explicit landscape modelling or growth and yield modeling, see http://www.cifor.org/online-library/research-tools/flores.html and Weiskittel *et al.* 2011.

Scenario modeling approaches

There are different approaches and tools used for scenario modeling. Based on the driving force of the model, scenarios can be categorized into *supply-driven or demand-driven scenarios*. In supply-driven scenarios, the target of modeling is to analyze the impact of change factor on supply of forest resources. Supply change factors include, for example, afforestation, strict forest protection or rehabilitation programme. In demand-driven scenarios, the modeling aims at analyzing impacts of use of resources on future forest conditions. Demand change factors include, for example, increasing use of wood-based energy and establishment or closing of a pulp and paper mill.

Supply-driven scenario modeling covers

- o statistical trend extrapolation of forest resources,
- o models predicting transition of a forest class into another class in a matrix of classes (e.g. EFISCEN http://www.efi.int/portal/virtual_library/databases/efiscen/) and
- o forest dynamics simulation models applied for inventory units (stands, trees) or their aggregates (e.g. OSKAR http://www.iiasa.ac.at/Research/GGI/docs/oskar.pdf).

There are also models that can be used for both supply-driven and demand-driven analysis such as MELA in Finland (http://fp0804.emu.ee/wiki/index.php/MELA) and Heureka in Sweden (http://fp0804.emu.ee/wiki/index.php/Heureka). MELA and Heureka have two main components: stand-level simulator and region-level optimizer. Simulator generates multiple development paths for stands. Optimizer can be used for seeking combinations of paths that fulfill the demand in terms of future forest recources, products and services. The approach and tools have been designed for boreal conditions where forests are managed as stands. In temperate forests with un-even aged and multiple species stands, stand simulators or diameter-volume state transition models are used (e.g. Buongiorno *et al.*1995). In tropical forests where hundreds of tree species appear, tree-level or species-group models are required for the simulation of dynamics and selective cutting (Macpherson *et al.* 2010).

It is also possible to integrate supply-driven forest resource scenario models with demand-driven forest sector models. Examples include integration of

- o EFISCEN and EFI-GTM (used e.g. for European Forest Sector Outlook Study EFSOS, http://timber.unece.org/index.php?id=55)
- o OSKAR and FASOM (used by IIASA, http://www.iiasa.ac.at/Research/GGI/docs/index.html?sb=8)
- o Atlas and TAMM (used by USDA Forest Service for RPA until 2000, http://www.fs.fed.us/research/rpa/what.shtml #2010RPA) and
- o MELA and SF-GTM (used by Metla to support National Forest Programme, http://www.metla.fi/julkaisut/workingpapers/2008/mwp075.pdf).

Scenario modeling can be *research-initiated* or *policy-targeted*. Research-initiated scenario modeling can be divided further into ad-hoc analysis addressing specific questions (e.g. Alig *et al.* 2001, Eid *et al.* 2002, Eriksson *et al.* 2007) or systematic work carried out with regular intervals (e.g. Adams & Haynes 2007).

The most common model to capture the trends with regular intervals is wood resource balance (WRB) comparing felling (removal or drain) against increment of growing stock. The utilization of wood resources has been considered sustainable as long as felling remains smaller than increment (see e.g. Forest Europe 2007, Indicator 3.1). A static measure such as WRB works best for so called normal forests where a forest is composed of even-aged fully-stocked stands representing a balance of age classes.

In conditions where age-class distribution is skewed, other measures are recommended. For example in Finland, three different measures are calculated regularly (see http://www.metla.fi/metinfo/tilasto/julkaisut/vsk/2009/vsk09_04.pdf, p. 179) for the 10-year period starting from the most recent national forest inventory year and compared with the recorded removals of preceding 10-year period: 1) potential cut, 2) removals maximizing net present value and 3) maximum sustainable yield. Potential cut defines the maximum removals from the forest and scrub land when forestry guidelines are followed and all restrictions for forest management due to protection and multiple-use of forests taken into account. In the removals maximizing net present value, the profitability of felling is also considered. Therefore, some forests are set-aside as non-profitable and some felling operations are postponed for later periods because of their value increment. The maximum sustainable yield defines the maximum removal that can be cut without decreasing future potentials.

The role of policy-targeted scenario modeling as a part of NFP is to forecast future forest resources, to assess resource use potentials and to evaluate optional strategies and policies. Model-based scenarios predicting what will happen as a consequence of different policies or strategies are used for example in Nordic countries (e.g. the Finnish National Forest Programme http://www.mmm.fi/attachments/metsat/kmo/5Ad5R83tH/KMO2015engl.pdf and the Swedish Forest Impact Analyses http://www.skogsstyrelsen.se/Myndigheten/Skog-och-miljo/Tillstandet-i-skogen/Tillgangen-pa-skog/) and in the United States (Resources Planning Act Assessment http://www.fs.fed.us/research/rpa/what.shtml#2010RPA). In Finland, policy-targeted scenario modeling has been carried out at national (e.g. Kärkkäinen *et al.* 2008), sub-national (e.g. Nuutinen *et al.* 2009) and local (e.g. Nuutinen *et al.* 2011) level.

Scenario modeling process

Scenario modeling can be used to address both slow and abrupt changes. Slow changes include for example the natural development of forest resources and can be predicted using simple forest dynamics simulation models. Abrupt changes such as decisions on policy measures have usually complex impacts on both forest resources and socio-economy. Therefore, the modeling requires explicit definition of interrelationships between different processes and actors, and quantification of other system parameters than just those concerning forests.

Typical steps in the scenario modeling process related to NFP and supported by NFMA include (see Fig. 1)

- collecting background information about the current situation, state and trends, of
  - forest resources covering round wood, fuel wood, non-timber forest products, biodiversity, water, recreation, carbon dioxide storage, etc.
  - land-use (including competing land-uses and their future pressure on forest land)
  - forest use
  - removal, consumption and markets of forest products
  - legislation and policies
  - stakeholders and their responses to policy measures
  - reference scenarios, e.g. global market scenarios
- collecting information about the national objectives
- design of alternative strategies or policies and related actions or measures
- prediction (simulation, model-based scenarios) of what will happen to forest conditions and use potential of forest resources in different alternatives; estimation of parameter values for the current and future forest resources, products and services
- evaluation of consequences of alternatives
- consensus building, sometimes iterating with the design of alternatives and consequent steps
- implementation
- monitoring progress of implementation to get feedback for the next scenario rounds e.g. to collect information about stakeholder response to policy measures.

For model-based scenarios, NFMA is the essential source for data on forest resources (usually aggregated data on age-volume classes or diameter distribution) and growth estimates. Furthermore, NFMA data can be used for modeling forest parameters such as biomass or carbon contents. Statistics on felling or afforestation activities can be utilized if business-as-scenarios are modelled.

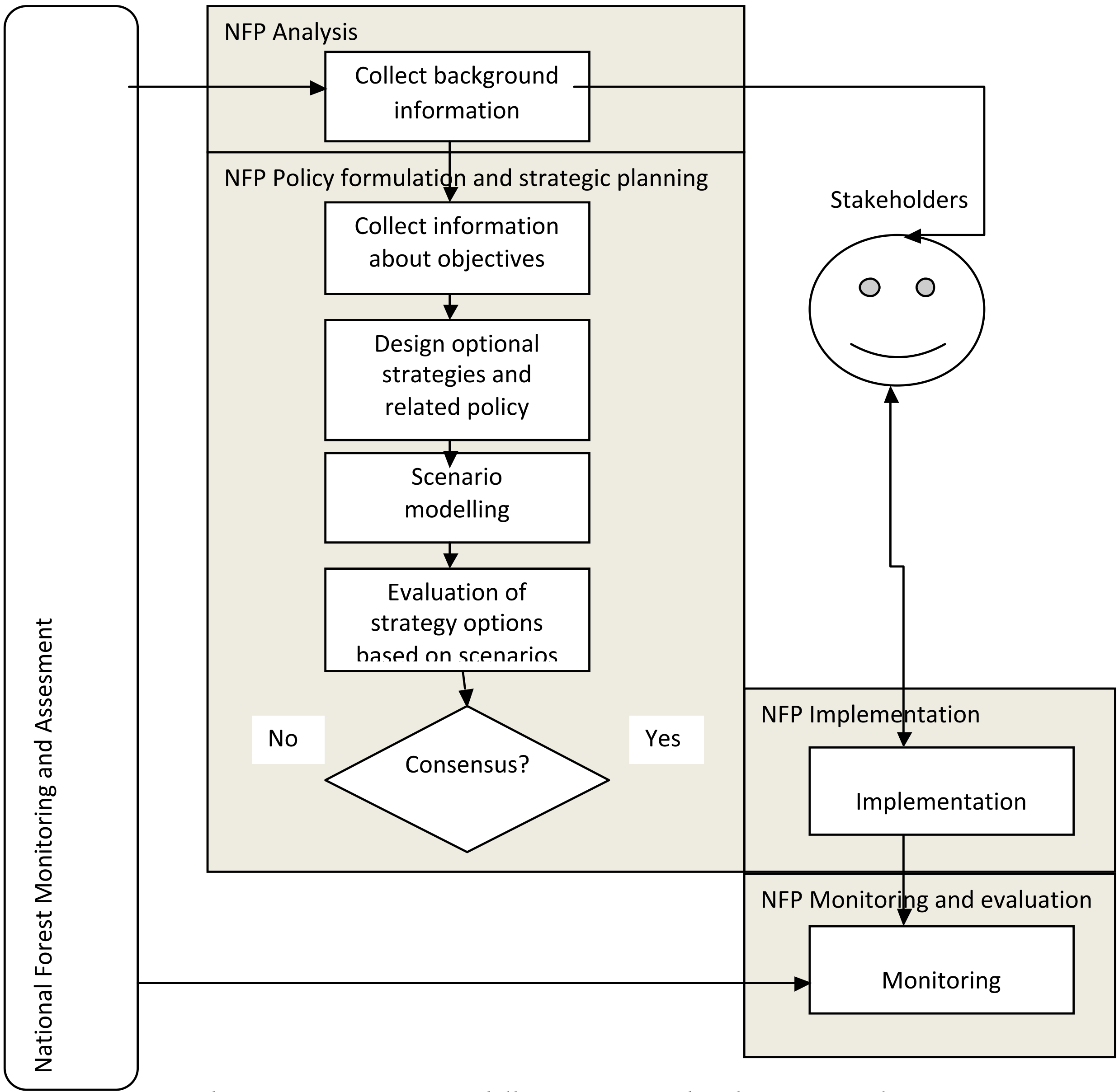

Figure 1. Typical steps in scenario modelling process related to National Forest Programme (NFP) and supported by National Forest Monitoring and Assessment (NFMA).

Discussion

So far scenario modelling has been applied in national forest strategy or policy processes mainly for boreal and temperate forests. However, the emergence of international mechanisms such as REDD+ (see UN-REDD Programme) increases interest in scenario modelling for tropical forests. For example, the strategic decisions between management options such as large-scale industrial plantations, small-scale community forest plantations, agroforestry, strict forest protection, forest rehabilitation and ecosystem approach for multiple-use forest management, or any combination of them, would benefit from analytic and quantitative assessment of different strategies in terms of carbon storage.

A big challenge for scenario modeling is to support national strategies and policies in the context of international agreements and global markets. Therefore the compatibility of national scenarios with regional or global reference scenarios becomes increasingly important. A partnership programme based on country reports such as Forest Europe or FAO's Global Forest Resource Assessment (FRA) offer motivation and a potential framework to harmonize national forest scenario modeling. In Europe, the bottom-up approach based on national forest scenario modeling would complement the top-down process applied in EFSOS 2011, in a similar way that North American Forest Sector Outlook Study (NAFSOS) is integrated with USDA Forest Service RPA. FAO supports the processes through National Forest Monitoring and Assessment projects and National Forest Programme Facility.

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Examples of scenario modelling as a part of policy and strategy processes:

the Finnish National Forest Programme: http://www.mmm.fi/attachments/metsat/kmo/5Ad5R83tH/KMO2015engl.pdf

the Swedish Forest Impact Analyses: http://www.skogsstyrelsen.se/Myndigheten/Skog-och-miljo/Tillstandet-i-skogen/Tillgangen-pa-skog/)

the United States Resources Planning Act Assessment: http://www.fs.fed.us/research/rpa/what.shtml#2010RPA

the European Forest Sector Outlook Study (EFSOS): http://timber.unece.org/index.php?id=55

Examples of scenario models:

EFISCEN http://www.efi.int/portal/virtual_library/databases/efiscen/

OSKAR http://www.iiasa.ac.at/Research/GGI/docs/oskar.pdf))

MELA http://fp0804.emu.ee/wiki/index.php/MELA

Heureka http://fp0804.emu.ee/wiki/index.php/Heureka